# 1986 Kiwifruit Production Meeting Proceedings

January 29 and 30, 1986

Held at the Agriculture Canada Research and
Plant Quarantine Station Saanichton, B.C.

*Sponsored by*
The B.C. Ministry of Agriculture and Food
and the B.C. Kiwifruit Growers Association

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## 1986 Kiwifruit Production Meetings

On January 29th and 30th, 1986 a horticultural meeting was held at the Agriculture Canada Research and Quarantine Station at Saanichton to discuss commercial production possibilities for kiwifruit (*Actinidia deliciosa*) in British Columbia.

Interest in this crop has been growing since the first few fruits were harvested off the experimental planting at the Research Station in 1983. This culminated in 1985 with 25 acres of commercial kiwifruit plantings being established in South Coastal B.C.. A further 30 acres will be planted during the 1986 growing season.

Due to this tremendous interest in kiwifruit and the limited local knowledge available, the B.C. Ministry of Agriculture and Food, and the Kiwifruit Growers Association of B.C. decided to bring together all the expertise from various areas of the world and make it available to local growers.

If any further information is required you may contact either;

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## 1986 B.C. Kiwifruit Production Meetings

Sponsored by B.C.M.A.F. and Kiwifruit Growers Association of B.C.

Registration Fee is $20.00 paid at the door on the 30th of January.

**Wednesday, January 29th**

| | |
|---|---|
| 10:00 a.m. - 12:00 noon | - Tour of trial plantings at Agriculture Canada's Saanichton Experimental station |
| 1:30 p.m. - 4:30 p.m. | - Tour of grower's plantings, including:<br>1) Vantreight's five acre pergola planting<br>2) Pat & Barb Brennan's half acre T-bar |

**Thursday, January 30th**

| | |
|---|---|
| | - Chairman, Brent Warner, Horticulturist, B.C.M.A.F. Sidney |
| 8:30 a.m. - 8:40 a.m. | - Opening remarks, Dr. Joe Molnar, Director, Agassiz Research Station |
| 8:40 a.m. - 9:00 a.m. | - Agriculture Canada (New Crop Development Fund) and B.C.M.A.F. (D.A.T.E.) funding of initial research plantings - Brent Warner, B.C.M.A.F. |
| 9:00 a.m. - 10:00 a.m. | - 'Kiwifruit Nutrition', Dr. Jim Beutel, University of California |
| 10:00 a.m. - 10:15 a.m. | - Coffee |
| 10:15 a.m. - 11:00 a.m. | - 'Greenhouse Kiwifruit Culture', Dr. Neil Miles, Ministry of Agriculture and Food, Ontario |
| 11:00 a.m. - 11:45 a.m. | - 'Commercial Kiwifruit Production Under Glass in the Channel Islands', Ian Stroud, Director, Fresh Food City Holdings |
| 11:45 a.m. - 1:30 p.m. | - Lunch |
| 1:30 p.m. - 2:00 p.m. | - 'Marketing of Kiwifruit in B.C.', Jim Alcock, Horticultural Marketing Specialist, B.C.M.A.F. |
| 2:00 p.m. - 3:00 p.m. | - 'An overview of Quality Control in Brlation to Marketing', Gene Tanimoto, President of the California Kiwifruit Grower's Association |
| 3:00 p.m. - 3:15 p.m. | - Coffee |
| 3:15 p.m. - 4:00 p.m. | - 'Kiwifruit Training', Dr. Jim Beutel |
| 4:00 p.m. - 5:00 p.m. | - 'Developments in Kiwifruit Production in New Zealand', Nick Pyke, D.S.I.R. New Zealand |

The lecture session on January 30th, will be held at the Pavillion on the Saanichton Research and Quarantine Station, Sidney.

G. Brent Warner, Horticulturist

Dr. J. M. Molnar - Director Agriculture Canada, Agassiz

It is my pleasure to open the first kiwi short course here at the Saanichton Research and Plant Quarantine Station.

A little over eight years ago, when I came to Saanichton from Ottawa, I noticed some funny looking vines growing beside the grape-demonstration plots. These were the first seedlings which were given to us by Henry Bailey, a French horticulturist, who believed that kiwi production was possible - and could be profitable - on Vancouver Island. Needless to say, at that time we did not take Mr. Bailey's recommendation too seriously. I was expecting that with the first serious frost the entire planting would be wiped out. Therefore we were surprised that the plants survived - even at -12° C - without suffering any damage during the winter. This is when we started to take the possibility of producing kiwi's in B.C. more seriously!

Since then, as you know, we have imported commercial varieties from both California and New Zealand - some of which are getting into production this year.

The interest in this project has increased over the last two years to a point where there are now over 25 acres in commercial plantings which, I am told, will increase this winter by another 30 - 40 acres.

This interest in kiwifruit production is very encouraging; however, I feel that there are still a number of unknowns about the commercial feasibility of kiwifruit production - especially on the Mainland.

The past year's growing season was particularly good and the quality of fruit produced on the Station was probably the best since the vines began to bear fruit.

We have sent some fruit to Ottawa - to the Minister of Agriculture's office - and they preferred the taste of 'Saanichton 12' to the Hayward variety.

We are planning to continue with the research on kiwifruit here at Saanichton. We plan to establish plots at our Abbotsford Substation and also at the Research Station in Agassiz where the climatic conditions are more severe than Saanichton. For these latter locations we could evaluate, in the field, the various varieties for their cold-tolerance, in addition to the laboratory work planned here at Saanichton by Mr. Pyke and Mr. Kempler.

Recently I received an invitation from the Chinese Academy of Sciences to visit China this year. They have promised to show me the various Actinidia

species grown in cultivation and also in the wild; perhaps I will be able to bring back some hardier plant material which we could include in our breeding program.

In the past, I visited California and New Zealand and benefitted a great deal; therefore I hope the visit to China will be equally beneficial.

I am glad that we were able to assemble some leading authorities from both New Zealand and California to teach us more about the culture of kiwifruit and to share their experience and knowledge with us.

Just about this time last year, I visited New Zealand where I met Mr. Nick Pyke and invited him to spend some time with us in Canada. I am very grateful to DSIR for letting him come here for a year and I am sure it will be beneficial for both DSIR and Agriculture Canada. I would like to take this opportunity to acknowledge the B.C. Ministry of Agriculture and Food for their financial contribution towards Mr. Pyke's transfer of work. Without their cooperation this visit probably would not have materialized.

This is just one example of the excellent cooperation between the two levels of government working together to bring to the growers of British Columbia the latest technology in agricultural research and production. I beleive Brent Warner should be commended for the excellent program he has put together. I would also like to thank the speakers for accepting our invitation to participate in the program. I am sure we all will find this day very informative and bring us closer to the day when commercial kiwifruit production in B.C. will be a reality.

Brent Warner - Horticulturist B.C. Ministry of Agriculture and Food, Sidney

Of the 25 acres of kiwifruit vines planted in the spring of 1985, 3 acres were partially funded by Agriculture Canada (New Crop Development) and B.C. Ministry of Agriculture (D.A.T.E. Program). These three sites were selected so that this crop could be studied on a large scale under three different managers. Essentially the breakdown on funding and labor went as follows:

Agriculture Canada - supplied plants, horticultural inputs, research technical assistance and money for trips to meetings in California.

B.C.M.A.F. - supplied trellis, irrigation system and research technical assistance.

Individual Farms - supplied land, equipment, and all labor.

The total share of costs was to have broken down approximately to 25% for the farmers, 25% for the B.C.M.A.F., and 50% for the N.C.D.F. However, due to unforseen or additional costs (one being drainage) higher costs were incurred on some plantings, and these were absorbed by the farmers. The farmers involved were Mr. Ian Vantreight and Mr. George Doney on Vancouver Island, and Mr. Harm Wernicke in Langley.

All of the kiwifruit vines purchased from California in the spring of 1985 were planted in British Columbia prior to the end of April. Growth initially was slow due to an unusually cold spring, but no plants were damaged by a record late frost in May. Temperatures for the week of May 9 - 15 were as low as +0.3 C at the Environment Canada weather station at Victoria International airport. Lows for the week ranged in the area of +2 C at this station. Minor frost damage to some leaves of the kiwifruit vines at Saanichton were observed. This did not affect the performance of the vines during the growing season.

The summer of 1985 was one of the driest ever recorded in coastal British Columbia and this caused some initial problems at plantings that did not yet have their irrigation systems completed.

The vines were delivered to the Wernicke planting on April 1st and planting commenced on the 2nd of April. The entire 10 acres was planted on the 2nd and 3rd of April. His irrigation system was functional within four weeks, well ahead of when the plants began to leaf out to any extent.

The Vantreight and Doney plants were put in cold storage 4.5 C (40 F) at Saanich Orchards on April 2nd. Mr. Doney removed the plants as he needed them and was finished planting by April 10th. Due to problems in field

preparation the Vantreight plants remained in storage until April 21st. Planting then occured over the next few days and was finished on April 24th. Both of these plantings had a considerable delay in the completion of their irrigation systems due to, in part, the dry year which put extremely heavy demands on local irrigation supply companies, for both parts and installation services. Both of these systems were operational by early June.

Costs for installation of these irrigation systems ranged from approximately $2,400.00 per acre for the Vantreight planting, to $3,200.00 per acre for the Doney planting. This extra cost for the Doney planting was due to it being located on a hillside and requiring pressure compensating emitters. As well, pond water is being used for irrigation, which necessitates using a much more expensive water filter. The costs for the Wernicke planting, excluding pump and delivery of water to the planting site, is also approximately $2,400.00 per acre. These are installed prices which include labor, whether it was hired or done by the farmer.

The only planting which installed a windbreak around the entire planting, was the Vantreight site. Cost for this was $4.00 per tree, plus an additional $1.50 to plant it and install an irrigation line. These trees are planted four feet apart, therefore, an average acre planting would require 200 trees for a cost of $3,000.00 installed.

All the plantings had soil and leaf tissue analysis done at the B.C.M.A.F. laboratory in Kelowna and these results were compiled by the student working for the project. This student was funded by both Agriculture Canada and the B.C.M.A.F. and was extremely useful in monitoring the conditions in the fields throughout the course of the growing season. It has been arranged with the growers and the B.C.M.A.F. lab. next year that a more comprehensive testing program will be carried out to study the progess of the plantings through an entire season. This will involve the growers doing all the sampling themselves and sending these samples to the lab. for an analysis. These tests will be done free of charge for two years so that we may obtain background data for future work with kiwifruit vines. No firm conclusions can be made based on only one sample, although some plantings with low tissue analysis for certain elements will be treated for that problem next year. By following what results these fertilizer applications have, we will be more able to assess the requirements of these vines.

Growth of the vines during this past season exceeded all our expectations. Survival rate of the vines were exceptional with less than 50 vines dying, out of over 5,000 vines transplanted.

The most uniform planting was the Wernicke planting at Langley, where very few of the vines failed to reach the six foot cordon wire and send laterals two to four feet down this wire. The initial drought problem at the Doney and Vantreight plantings held them back a little, although later growth was very good and most of the plants did establish a main leader to the six foot wire.

In August of this year the Tanimoto family from California were here for four days to check on their kiwifruit nursery stock which they had supplied. They were very impressed with the plantings and stated that the growth was better than what they would see in California. This was encouraging, since Gene Tanimoto is the President of the California Kiwifruit Grower's Association.

During this season, the growers of kiwifruit in British Columbia formed an association, appropriately entitled, the Kiwifruit Growers' Association of British Columbia. The aims of this association are to provide information and assistance to their members in growing, harvesting, packing and storing this fruit.

The fall came very early this year, with a hard frost occuring on October 8. This caused leaf burn and some tip dieback at the Wernicke planting, but this was not serious. Injury on the other plantings was not apparent at that time.

Winter came early to the south coast and temperature recordings of -10 C were recorded on consecutive nights during the week of November 20 - 27. Temperatures during that week dipped to -17 C in Langley. At this time the majority of the plants at Sidney appear to be undamaged. The plants at Langley however have suffered severe damage and most appear to be dead at the ground level. This planting will be replanted and steps taken to insure that the chances of this happening again are minimized.

1986-87 will be a critical year for this project. We expect to have some fruit, as much as 15 - 25 fruits per vine and this should allow us to start to assess our quality. If the quality is as good as the small amount of crop which has been harvested at Saanichton over the past few years, then the only major unknown will be the quantities which will be determined within three years. As well, work will begin to look at frost protection equipment and protective collars for main trunks. This years' early frost was the lowest recorded temperature on that date for 30 years. Hopefully we will not experience this type of fall for another 30, but by the fall of 1986 we will have some recommendations in place for protecting the plants.

Part of this joint project has involved bringing a research scientist, Mr. Nick Pyke here from New Zealand and he will be addressing these problems with his research this year. As well, he will be out visiting growers and assisting myself with some extension work.

Kiwifruit growing anywhere in B.C. except in a greenhouse is still experimental. We will be conducting research trials over the next five years to see how the plants perform both on the Island and in the Fraser Valley.

Currently, I am not nor is anyone else associated the the B.C.M.A.F. recommending kiwifruit planting in the Fraser Valley. The planting at Langley is part of an experimental program to evaluate performance. We are not yet confident that this area or any other area of the Valley can grow

Kiwifruit vines. In the next five years we will be testing various frost control systems and this will hopefully give us the protection we need to produce this corp.

Currently the only guaranteed way to produce kiwifruit in the Valley would be in a greenhouse and trial work will be done at Saanichton starting this year to test the economics of this production. Figures for other areas of the world would lead us to believe that this is one way we could definately grow this crop and produce a superior product. If you require further information in this regard please check with the Saanichton Office of the B.C.M.A.F. or the B.C. Kiwifruit Growers' Association. For more information:

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Dr. Jim Beutel - University of California

It's nice to be here in B.C. and meet all the new potential kiwifruit growers. It reminds me of Southern California 10 or 15 years ago. Hopefully many of you will become successful kiwifruit growers since obviously you do have sites where you can grow kiwifruit.

I can remember when Henry Bailey first came to California and told us that there were kiwifruit plants being grown on Vancouver Island and his hope has paid off and it's too bad he isn't here to see the beginning of this industry.

I would like to cover several topics including nutrition.

Firstly lets look at some basics.

Male Plants - The difference between male and female is that in bloom male flowers only have stamens. Also generally male flowers are found grouped many to a cluster.

Female Plants - These flowers are generally born singly or in groups of three and the flowers have both stamens and pistils. The stamens on female flowers bear sterile pollen.

The mechanics of pollination are still being researched around the world but if you have a male and female ratio of between 1 to 5 and 1 to 8 and you use bees at 3 hives per acre you should get large fruit.

If bees do not do a thorough job you will get some cracks or deformities on one side and if you cut through these you will find there are no seeds in that fruit. Pollination is extremely important in kiwifruit production. Large fruit contain 700 to 1000 seeds.

KIWIFRUIT VARIETIES

There is only one commercially grown variety - Hayward since it is the largest and best looking. Anything else is second rate. Other varieties are only important to botany enthusiasts or variety hobbiests. Most male plants sold commercially will provide adequate male pollen at the proper time.

FROST DAMAGE

When kiwifruit began to be grown in California there was alot of frost damage incurred in the initial years. It happened again this year in California. We have growers who have not learned the essential lesson that if you are to grow kiwi you must have frost protection. This generally comes in the form of sprinkling which when the water freezes gives up energy which heats the vine and keeps it from freezing.

"Frost protection is ESSENTIAL for success in kiwifruit production"

As the vines get older they become hardier. Italy and France suffered extensive damage to their kiwifruit vineyards both 1 year and 4 years ago. Many plantings were saved by plant conditioning. By this I mean, withholding the water and/or stopping the fertilization to harden the plant in the late summer or fall.

Mature vines will tolerate temperatures of -17 or -18 C when they are fully dormant. Frost protection is crucial during the first two or three frosts in the fall when the plant is trying to get ready for winter. This reduces the severity of the first 3 or 4 freezes. Frost protection is also crucial in the spring when the first buds come out. The traditional type of frost protection in California is the overhead rain bird impact sprinklers.

WIND DAMAGE

Long canes in the spring are extremely susceptible to damage. This type of obvious damage can cause severe fruit losses. Even more frustrating is damage to the fruit caused by wind rub which makes the fruit a cull.

The damage you may never notice is the damage you get when you get coastal breezes blowing over 5 mph constantly. This will stunt the plant.

WINDBREAKS

In California Lombardy Poplar is one of the favorite fast growing windbreaks. Cuttings stuck in the ground will grow 2 to 3 meters per year and you will have a windbreak in three years.

Other types of windbreaks include willows and some conifers.

PROBLEMS WITH WINDBREAKS

They can remove water and nutrients from the planting. A road between the hedge and the planting is the easiest way to correct this problem. Root cutting may also be necessary to keep the plants in bounds, particularly the willow and poplar.

DRAINAGE

Kiwifruit need well drained soil to be grown satisfactorly. Drainage is extremely important in many of your local plantings. If water logging occurs after the leaves have appeared in the spring it can be devastating to a kiwifruit vine. You should have a minimum of three feet of well drained soil before you even consider planting.

Another way of improving drainage is to plant the vines on a raised bed (minimum of 1 foot). These beds should be made the year prior to planting.

## IRRIGATION

Frequent irrigation is crucial. That is, at least twice a week when the plants are young.

There are many methods of irrigating kiwifruit but no general agreement on the preferred way.

Trickle emitters are used in many plantings and these supply about 1 gallon or 4 litres per hour. Small mini sprinklers are also used and these supply 5 to 15 gallons per hour of a spray. The systems must be large enough to supply the vines enough water when they reach maturity. These pipes can be either mounted on a wire or simply laid on the ground. When the system is on top there is a problem with pruners cutting the line and when it's on the ground there is a problem with getting the prunings away from the sprinkler as well as the problem with people stepping on the line and breaking the emitters.

Lack of water will result in poor growth and small fruit. Kiwifruit require more water, more frequently than any other crop we grow in California.

## EXPENSES

If you contract the planting out and have a first rate installation put in it will cost you between $18,000 to $20,000 U.S. per acre for materials and labour. This includes the plants, $2,000 U.S. by the time they are planted, the trellis system, $2,000 to $4,000 per acre, drainage and irrigation $2,000 to $4,000, frost protection $2,000 and up, cultural care for three years over $2,000. In addition if you borrow money you will be paying interest.

If you have to borrow money, it will take you at least 10 years to return your investment.

You can learn alot from the first plantings you make. Succeeding plantings will be less costly and more successful. There is no bonus today in being the first grower to have the first 1,000 packed trays of fruit. Those days are gone and from now on there will be a stable kind of market so don't jump into this thing too much at one time.

There is no data available to show how much fruit you will be able to produce on your vines here in B.C.. You may be successful and produce 2,000 trays of 7lbs. each per acre. This is considered a good yielding planting.

## NUTRITION

Kiwifruit are very sensitive about application of fertilizer to their roots. They burn much more easily than apple or peach trees. So be very cautious in your fertilizer application.

Fertilizer 34-0-0 Ammonium Nitrate

1st year - 2 oz per vine - 3 times during first year, May, June and July

2nd year - 4 oz per vine - 3 times during second year, March, May and June

3rd year - 8 oz per vine - 2 times per year, March and May

4th year - 12 oz per vine - 2 times per year, March and May

5th year - 16 oz per vine - 2 times per year, March and May

6th year - 32 oz per vine - March
16 oz per vine - May

and so on for the following years.

This equals 1 unit Nitrogen per vine per year. Which equals 150-200 units per nitrogen per acre per year depending on whether you have 150 or 200 vines per acre.

I would not use any more if I had 300 vines or much less if I only had 120 vines.

This recommendation would be for the life of the planting.

If you need other elements such as potassium these elements can be supplied by additional fertilizers applied either foliar or on the soil surface.

In reviewing both the New Zealand and California standards it is amazing how close they are on critical values, that is the percent of nutrients the leaves should have to make good growth and fruit production.

## DEFICIENCIES

Nitrogen - leaves are pale, poor vigor on plants
- vines should be in range of 2.5%

Potassium - rolling of leaves, some form of burning
- low vigor and small fruit
- leaf level below 1.5% can cause problems
- generally leaves run from 2.0 to 2.5% potassium
- problems can occur especially in areas of poor soil drainage

Zinc - deficient in California
- leaves are small, elongated, yellow mottling between veins.
- iron deficiency usually has brighter yellow

Manganese - often deficient - normal shaped leaves with yellow mottling between veins.

Most nutrients are kept supplied by foliar sprays or liquid feeding of a chelated material.

Amount of Water Required for B.C. Vines

| | Drip System | Sprinkler |
|---|---|---|
| 1st year | 2 gallons per day | 4 |
| 2nd year | 4 gallons per day | 8 |
| 3rd year | 8 gallons per day | 16 |
| 4th year | 16 gallons per day | 32 |
| 5th year | 24 gallons per day | 40 |

When you use a dripper almost 100% of the water goes into the soil. However when you are using a sprinkler you will get some losses due to evaporation so therefore you need more water.

These are per day figures for 70 to 80 F weather. If you are irrigating every second day you would have to put on twice as much water, every third day three times as much water and so on.

To measure to see if the roots are at a proper moisture level one can use a tensiometer. A reading of 30 on the tensiometer is an acceptable range for kiwifruit.

Dr. Neil Miles - Ministry of Agriculture and Food, Ontario

Since 1981 research on Protected Fruit Culture at HRIO-Vineland has investigated the feasibility of kiwifruit production within a Protected Environment Structure. Peach is the primary crop grown but other crops being studied, in addition to kiwifruit, include Vinifera grapes, Granny Smith apples, strawberries and Tayberries. The 7-bay gutter connected greenhouse structure (0.22 ha or 0.5A) with 3.4 M (11 ft.) gutter height fiberglass walls has a double polyethylene plastic roof which is removed from June 1 to September 15. Forced air gas heaters prevent low temperature stresses, and the structure is cooled with side vents and fans. Water and fertilizer are applied through a trickle irrigation system. Temperatures during dormancy range between -7 to 10 C with a gradual transition to ambient summer temperatures. Bud break occurs in early March, flowering in mid-May and kiwifruits are harvested in mid-November.

'Hayward' vines were planted in 1981 at a spacing of 6 m x 3.4 m (20 ft. x 11 ft.) or 490 vines/ha (198 vines/A). The vines were trained to a T-Bar trellis which was expanded to a pergola system in 1985. Flowers were hand pollinated 4 times per season, at 2 to 3 day intervals, with pollen purchased from commercial sources. Both dormant pruning and summer training were used to develop vine structure and control vigor.

Insecticide or fungicide sprays have not been required. No insect problems have been noted but certain fungal and bacterial pathogens have been identified. Weeds were controlled by black plastic mulch over the entire soil surface.

A once-over harvest was made in mid-to late November of each year. Yields were as follows: 1983 - 4.8 t/ha; 1984 - 19.1 t/ha; and 1985 - 46.9 t/ha. The 1985 yeild was the equivalent of 12,875 trays (281 trays - 30 count, 4781 trays - 35 count, 7813 trays - 45 count) plus 642 - 12 x 1 lb. bags per hectare. There were 4.7% cull fruit by weight. The maturity of the fruits harvested in 1985 was 9.2 Brix and 16.4 psi. The value of the 1985 crop was estimated to be $146,000 (Toronto wholesale $10.50/tray, $17.00/12 - 1 lb. bag). Estimated direct costs of production were $121,700/ha (Orchard Management $18,500; Marketing $66,500; Structure $22,500 and Taxes, etc. $13,000). Thus an estimated gross margin of $24,300 was generated. The size of the fruit in 1985 was smaller than 1984, possibly due to over production. However, the vines remain vigorous and healthy so the potential to sustain or even surpass that level of production seems possible.

The kiwifruit seems ideally adapted to the environment created in the Protected Environment Structure. Production of large crops of high quality and fully mature fruits can be achieved. Economic feasibility of Protected Kiwifruit Culture depends on sustained high levels of production, stable market value of the crop, and an economical but efficient and durable structure.

KIWIFRUIT PRODUCTION BY SIZE - 1985

| Count | t/ha | Trays/ha[1] |
|---|---|---|
| 30 | 0.9 | 281 |
| 35 | 15.3 | 4781 |
| 45 | 25.0 | 7813 |
| Bag | 7.4 | (642) |

[1]Tray = 3.2 kg (7 lb.)
Bag = 12 x 1 lb. (5.45 kg)

KIWIFRUIT YIELD UNDER PROTECTED CULTURE

| Harvest Date | Firmness | Soluble Solids | Yield |
|---|---|---|---|
| | psi | Brix | t/ha |
| Nov. 16/83 | 12.0 | 9.5 | 4.8 |
| Nov. 29/84 | 6.5 | 14.1 | 19.1 |
| Nov. 14/85 | 16.4 | 9.2 | 46.9 |

Ian Stroud - Director, Fresh Food City Holdings

## GUERNSEY AIRPORT
## METEOROLOGICAL OBSERVATIONS

| DATE | AIR | | | Grass | Soil (cm) | | Days with | TOTALS FOR YEAR TO DATE | |
|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | Min | 30 | 100 | Ground Frost | Sun | Sunless Days |
| JANUARY 1983 | 9.8 | 6.3 | 8.0 | 4.7 | 7.7 | 8.6 | 1 | 40.2 hrs | 13 |
| FEBRUARY 1983 | 6.2 | 2.2 | 4.2 | 0.7 | 5.1 | 6.9 | 13 | 125.6 hrs | 16 |
| MARCH 1983 | 9.0 | 4.6 | 6.8 | 2.6 | 7.5 | 7.6 | 8 | 217.1 hrs | 25 |
| APRIL 1983 | 10.4 | 5.3 | 7.8 | 3.2 | 8.9 | 8.7 | 3 | 371.8 hrs | 29 |
| OCTOBER 1983 | 14.5 | 9.8 | 12.2 | 6.9 | 13.8 | 15.0 | 4 | 1621.5 hrs | 39 |
| NOVEMBER 1983 | 11.8 | 8.6 | 10.2 | 6.4 | 10.9 | 12.3 | 1 | 1684.7 hrs | 48 |
| DECEMBER 1983 | 9.9 | 6.2 | 8.0 | 3.3 | 8.2 | 9.8 | 6 | 1765.4 hrs | 59 |
| JANUARY 1984 | 8.8 | 4.1 | 6.4 | 2.3 | 7.0 | 8.5 | 7 | 61.1 hrs | 11 |
| FEBRUARY 1984 | 7.5 | 4.0 | 5.8 | 1.4 | 6.2 | 7.4 | 8 | 147.5 hrs | 19 |
| MARCH 1984 | 8.2 | 4.2 | 6.2 | 1.4 | 6.4 | 6.9 | 5 | 236.7 hrs | 23 |
| APRIL 1984 | 12.3 | 6.0 | 9.2 | 1.9 | 9.4 | 8.7 | 10 | 517.1 hrs | 24 |
| OCTOBER 1984 | 14.7 | 10.7 | 12.7 | 7.5 | 13.8 | 14.6 | 1 | 1824.9 hrs | 38 |
| NOVEMBER 1984 | 12.4 | 8.5 | 10.5 | 6.3 | 11.2 | 12.5 | 3 | 1878.3 hrs | 47 |
| DECEMBER 1984 | 10.0 | 6.1 | 8.0 | 3.4 | 8.5 | 10.1 | 5 | 1938.9 hrs | 59 |
| JANUARY 1985 | 6.0 | 1.9 | 3.9 | -0.7 | 4.6 | 6.6 | 20 | 49.5 hrs | 9 |
| FEBRUARY 1985 | 7.3 | 3.3 | 5.3 | 0.9 | 5.5 | 6.6 | 14 | 173.7 hrs | 16 |
| MARCH 1985 | 8.5 | 3.9 | 6.2 | 1.5 | 6.6 | 6.9 | 10 | 316.3 hrs | 23 |

Discussion Document No. 2

## BRIEF NOTES ON KIWI GROWING UNDER GLASS USING SOUTHERN HEMISPHERE PLANTS

1) Assuming conditions are as in Guernsey.

2) Buy good guaranteed two year old Hayward females and Matua males at the end of New Zealand dormancy (Aug), or buy grafted plants from California.

3) Put into cold storage for approximately 2 weeks. Pot-up in September in 7 inch whalehide pots using a mixture of peat plus 10% plygrow - P H 6.5 - no feeder. Water in.

4) Approximately 10 days and thereafter feed 1-1-1 then 1-0-1 etc., 50% shading for one month.

5) Allow the strongest shoot to grow approximately 8 to 9 feet before 'T'ing.

6) Plant at either 10 x 10 or 6' x 10' spacing (depending on how commercially minded you are!) the following March and force dormancy.

7) Same year make 'T' and about 4 laterals per plant.

8) Year 2 - 2 to 5 tons per acre will be produced and completion of the lateral system. Using grafted plants (2 year grafts) your expected yield in the 2nd year would be 5 to 10 tons.

9) Year 3 expect between 10 to 15 tons of fruit per acre. Yield from 2 year grafted plants should be 15 to 20 tons.

10) Always ensure good drainage and keep well ventilated winter and summer.

11) Training methods are different to New Zealand outdoor growing because growth is so rapid.

If plants were purchased from a Northern Hemisphere source in February or March, planting would be best and no cold storing would be needed. Buy towards the end of dormancy period whatever Hemisphere you buy from.

Discussion Document No. 3

## MAIN FACTORS IN KIWIFRUIT GROWING UNDER GLASS IN GUERNSEY

1) Dormant period - December to March.

2) Flowering period - May.

3) Pollination period 2 weeks in May.

4) Harvesting November to December.

5) Guernsey at present grows male and female plants together ratio 1 : 4.

6) Future plantings will be seperate: Being an island far from commercial sources of pollen it could be dangerous in short term to dispense with male plants.

7) Canada however being close to California could dispense with male plants thereby increasing potential output 25% over what is at present achieved in Guernsey.

8) Fruit is picked at 6.5 to 7.0 Brix level and immediately cold stored in high humidity (95%) 0 deg. C, graded and packed at a later date.

Discussion Document NO. 4

## ECONOMICS OF KIWIFRUIT GROWING IN COMMERCIAL GLASSHOUSES IN GUERNSEY

A) Year 1 - Plant 2 year old plants.
Year 2 - 2 to 5 tons per acre = 667 to 1667 trays per acre.
Year 3 - 10 to 15 tons per acre = 3333 to 5000 trays per acre.
Year 4 - 20+ tons per acre = 6667+ trays per acre.

B) 3 Kilos of fruit per tray.

C) Fruit tends to larger sizes 20 per tray upwards, average being 33.

D) Fruit is of high quality, good colour, Guernsey Kiwifruit obtains premium price. No frost or rain damage experienced as with outdoor crop.

E) Picked in November/December packed and sent to Rotterdam for storage. Released during end of March/April into European markets.

F) Past average prices £8 - 11/tray (16 - 22 Canadian dollars)

G) We bridge the gap between European producers in France, Italy, Greece etc., and first arrivals of New Zealand.

H) Our November/December 1985 crop is alreay in Rotterdam.

I) Guernsey has very high costs. i.e. energy, transport, therefore it has to grow products that fetch premium price compared to other traditional crops, i.e. tomatoes.

J) Kiwifruit requires no heating on Guernsey.

K) Manning of 1 person per acre only.

L) Till now growers have not attempted to grow other crops with kiwifruits during first years so start up costs can be high, however, research has shown that a method of growing is possible that will allow another crop to be grown simultaneously. This will help growers wishing to come into Kiwifruit production from other products.

R. J. Alcock - Horticultural Marketing Specialist, B.C.M.A.F.

Successful marketing of kiwifruit, like all other food items, is a large and complex challenge! Strong efforts and expertise are essential to success and we have seen an outstanding example of this by the growers and marketers of kiwi.

From a visual impression, a kiwifruit doesn't make much of an impact! A dull, brown, fuzzy, elongated object about the size of a large egg, is not a fruit most people think about putting in their mouth. We don't generally like the feel of fuzzy things in our mouths and somehow, fruits which are shiny, bright red or orange stimulate our appetite much more than those which are dull, fuzzy and brown. However, as the world population has rapidly been finding out, mainly over the past 5 years, the kiwifruit is really a delicious fruit. All you need to do is cut the kiwi in half and scoop out the delicious, fresh, clean tasting internal portion and leave the thin, brown, fuzzy skin alone. Of course, you can peel a kiwi as well.

World production of kiwifruit is, as probably most of you know, centered in relatively few areas. New Zealand is the leader with production in 1985 estimated at 81,000 metric tons or close to 180 million pounds - about 24,000,000 trays or 900 million individual kiwifruit. New Zealand has about 10,000 acres currently in full production and there is a lot more coming on. Production in 1988 is forecast at 200,000 metric tons from 30,000+ acres. What that means is that there is a fantastic marketing challenge facing the New Zealanders as well as all other production areas.

New Zealand is not alone in the game! While they have been producing kiwifruit since the 1930's, the first exports did not take place until 1953, in which a small shipment was made to London. Seven years later, Gary Hammond of David Oppenheimer & Associates, a long established produce broker and wholesaler in Vancouver, brought the first kiwifruit into Canada from New Zealand. Over the past 20 years, I regard Gary Hammond and Margaret Guy as the Deans of Kiwifruit marketing in Canada. I'll mention more about the Canadian kiwifruit deal in a few minutes.

Just to name some of the other main kiwifruit production areas of the world, California, which harvested 16,200 metric tonnes in 1984; France, 5,100 tonnes in 1983; Italy, 8,000 tonnes; Japan 4,000 tonnes; and finally, Australia with 1,137 tonnes. All these production areas are forecasting large production increases as is New Zealand. By 1988, the United States is expecting 40,000 tonnes, 88 million pounds, a 250% increase over 1984. France is expecting 12,000 tonnes, a 250% over 1983. Italy is expecting 40,000 tonnes by 1985, a fivefold increase in just four years! Japan is expecting 18,000 tonnes in 1988, a 4½ fold increase in four years, and Australia expects to produce 5,000 tonnes in 1988, almost

a 4½ fold increase in four years. Everyone's going to have a lot of kiwifruit to sell.

While there is tremendous potential for increased consumption of kiwifruit worldwide, most marketers see a pressure situation developing with regard to quantity and price. Only the best quality will sell and price at grower level is expected to decrease somewhat. How much is anyone's guess. Consumer demand for a single item is a very complicated subject with the choice to the consumer and promotional events ever increasing. International consumer demand will have to increase very fast to balance the increasing world supply. B.C. growers who seek to sell to the wholesale, retail, and food service markets will certainly be price takers; the landed price of imports and quality is what sets the standards. I'm sure Mr. Tanimoto will be giving us some valuable insight to quality criterion, in discussion of the federal marketing orders, U.S. grades and its importance to these challenges.

PACKS OF KIWIFRUIT

Shippers in both California and New Zealand do a fine job of packing their product as most of you probably know. Kiwi sold in Canada are sized very closely into 25, 27, 30, 33, 36, 39, 42 and occasionally 44-46 and contain approximately 7.5 to 7.7 pounds per case. Uniformity is an extremely important marketing criterion and this is the reason kiwifruit are sized to such a fine degree similar to apples, pears, etc. Remember, people buy them each! At anywhere from 39¢ to 69¢ or $2.50 to $3.00 per pound. These trays are 5 cm. deep by 29 cm., and in many cases, are individually wrapped with a sheet of light polyethylene to protect against moisture loss and contain a preformed plastic insert to hold the individual fruit gently in place. The most popular sizes generally are the 33 - 39 count. A portion of fruit is also packed into one pound poly bags. How B.C. growers package their kiwifruit will depend largely on where they are going to sell it and how much protection is required for shipping. The case used by California and New Zealand in addition to protecting the product in an excellent manner, provides a good display box and you often see the flats openly displayed.

PRICING OF KIWIFRUIT IN BRITISH COLUMBIA

Generally, the five year average landed import prices of kiwifruit on the Vancouver market have been strongest in the May to June period and lowest during January and February. Source of supply from May through October is primarily from New Zealand and from October to April primarily from California. If we take a median landed price during the low period, this would be in the range of $10.50 to $11.00 per flat and during the peak period of April to June, the median price would be in the range of $15.00 to $16.00. However, during the past five years, there has been a large

spread in prices with January being as low as $7.00 and as high as $14.00. May has had a range from $12.50 to $19.50 so keep in mind in one year of the past five prices were as low as $7.00 to $12.50. The basis for projections is always made largely on experiences of the past, but the International kiwifruit market is certainly set for some dramatic change. What you can expect to get for your kiwifruit is, at best, what has occurred over the past five year average. I feel there is reason to be very conservative on estimating future prices.

THE CURRENT DEMAND FOR KIWIFRUIT IN B.C. AND CANADA

Kiwifruit is still a relatively low volume item in B.C. and Canada. In 1984, we imported 1,848,000 pounds from New Zealand and 2,213,000 pounds from California for a total of 4,061,000 pounds into Canada. This means we have a national per capita consumption of approximately .17 pounds per capita annually. While B.C. has 12% of the national population, industry marketers estimate that approximately 800,000 pounds of kiwi are consumed in B.C. annually. This means B.C. consumes 20% of the total Canadian imports and has an estimated annual per capita consumption of approximately .30 pounds. Our Vancouver wholesale unloads volume is estimated at 637,000 pounds annually, which checks reasonably well. This low consumption is the conservative news. The interesting part is that from 1977 to 1983, the sales of New Zealand kiwifruit increased five-fold and there is ever indication that this increase in consumption is continuing as there is generally good supplies on a year-round basis and a strong promotional support program. Marketers in Canada of New Zealand kiwifruit forecast a 170% sales increase in 1985 over 1984.

The increase in consumption of kiwifruit has not happened by chance! The New Zealand Kiwifruit Authority currently assesses growers 34¢ per tray and 19¢ per tray to the six licensed exporters in Auckland. This generates an International marketing budget of approximately $10 million dollars, and with the forecast volumes between 1985 and 1990, over $100 million will be spent on marketing promotions internationally. I'm not sure what the budget for Canada is, but if it is proportionate to United States sales, expenditures would be in the order of $200,000 to $250,000 annually, most of which is currently spent in Ontario and Quebec.

The California Kiwifruit Commission is also expanding its promotion program rapidly and targeting its programs where there is greatest potential for growth. During the past year, this has focused on Los Angeles, San Francisco, Minneapolis/St. Paul, Chicago, Boston, Dallas, Philadelphia, New York, Toronto and Montreal. In 1984, the total budget was $673,100. Direct promotion expenditures were $250,000 for radio, magazine and trade journals, $290,000 for Point of Sale flyers, studies, surveys, advertising preparation, bookelts and information sheets, recipes, etc. The balance is made up of participation at trade shows, staff costs, etc.

All this promotion is of course, helpful to growers here as well as all areas of production. I have a ring binder of samples of promotional materials from both the New Zealand Kiwifruit Authority and the California Kiwifruit Commission dealing strictly with kiwifruit.

UTILIZATION OF KIWIFRUIT AND CONSUMER PERCEPTIONS

Kiwifruit is sold primarily as a fresh fruit which is, of course, where the greatest demand is as well as potential for profitable returns. Indications are that most kiwifruit is used as a combination dish with fruit salads, sauces and deserts. They are utilized to some extent as topping on pastries. A major positioning effort has been made similar to strawberries to include kiwifruit in a wide variety of preparations at both food service and home use. Few people eat a whole kiwifruit and very few use kiwifruit at all three meals. However, kiwifruit has some highly marketable nutritional characteristics which are particularly appropriate to our area. Kiwifruit is low in calories, only about 45 calories per fruit. It is remarkably high in Vitamin C containing 230 percent of the U.S.D.A. minimum recommended daily requirement. It is an excellent source of potassium (contains more than a 6-inch banana - one of the best sources) and has virtually no cholesterol, sodium or fat! In addition, it is an excellent source of fiber. This information was developed by funding a nutritional composite analysis study of kiwifruit and will be a very useful marketing tool in increasing the consumption and sonsumer demand.

One of the most innovative producers of kiwifruit in California has been Alkop Farms, who has produced a wide range of products from kiwifruit. Chunky pulp kiwifruit, which is similar in texture to apple sauce, is sold in 4-gallon pails and used as yogurt base and ice cream toppings. For certain seasons, Alkop even had McDonald's selling kiwifruit sundaes. However, McDonald's Canada report that the response was not as good as expected and that they would not likely be repeating this promotion in the foreseeable future. The limited consumer acceptance was believed primarily due to the limited familiarity of the flavour. Other products being researched by Alkop include sliced, peeled and diced fruit for canning, juice concentrates, wine and brandy bases, and dehydrated fruit. One producer in Chico California, with just 3½ acres of kiwifruit, put in a small commercial kitchen and processes his grade outs into kiwi, kiwi-orange and kiwi-hot pepper jams and kiwi vinegar. In addition, kiwis are dried into chips which they mix with almonds and banana chips which they call a Trail Mix snack. These products are marketed primarily at Farmers Markets throughout California.

Consumer research on perceptions of kiwifruit in the United States puts kiwifruit as a hot new item. Of the persons who purchased kiwifruit in the past two surveys, half of these were purchasing for the first time. In comparing the number of first time purchasers for different items,

kiwifruit was mentioned by 23% of the respondents. Female shoppers were twice as likely to purchase kiwifruit as male shoppers. Purchasers of kiwifruit tend to be from higher income households. Thirty percent of the respondents earning over $30,000 U.S. ($42,000 Canadian) annually, had purchased kiwi in the past year. While this study was conducted throughout the U.S., similar trends are believed to take place in Canada. We know that on a per capita basis, consumption of kiwifruit in British Columbia is higher than the rest of Canada, which quite likely is due to the higher incomes and longer period of promotion.

As you can see, kiwifruit marketing presents a lot of challenges, but also real opportunities. The interest here today is a good indicator that you people are pursuing both with vigor and I look forward to working with you.

Thank you for your attention and this opportunity of speaking with you.

Gene Tanimoto - President of the California Kiwifruit Grower's Association

## PROPER SELECTION OF NURSERY STOCK

1. Variety - By far 99% of all the fresh fruit market in kiwifruit utilizes the HAYWARD variety. From my experience, there is no noticable difference between the New Zealand Hayward and the California "Chico" Hayward.

2. Container Versus Bare Root - Both are acceptable, bare root kiwifruit vines are planted in February to April with good results. Containered vines are usually planted in September. My preference is in bare root starts.

3. Grafted Seedling Rootstock Versus Cutting - This is a difficult item to discuss. Research in vigor, production, and longevity has not been conclusive, let alone an evaluation of disease resistant rootstocks. Preliminary reports in California would indicate that during the first 6 years, cutting and grafted vines do equally well.

   Again my preference is grafted seedling rootstock.

Regardless of preference, when shopping for nursery stock, look for large caliper, stock greater than 3/8" in diameter - (preferably 1/2"). Most nursery stock should be 2 years old. If grafted, the scion should have been grown for a full season before you purchase the vine.

## TRAINING VINES

Your first and second year will be spent hovering over your vines, your mind filled with indecision. As Jim Beutel will elaborate on this later, I shall not bore you with details. I'll leave you with some basic ideas.

1. Don't rush to get your vines into production at the expense of good vine growth. It is possible that without sufficient winter pruning the first three years you will "over-crop" and plant structure will suffer. (Certainly - this does not mean that you shouldn't try to grow your vines as quickly as possible - just don't "over-crop").

2. Don't be afraid to cut inappropriate growth off. Always train the most vigorous cane.

SPRAY PROGRAM

Worst Pests in California:

1) Greedy Scale - Controlled through dormant spray. (Imidan and Oil)

2) Omnivorous Leaf Roller - Controlled during growing season; monitor moth traps, sprayed monthly following peak flight with Imidan, Dipel.

3) Botrytis (Post Harvest) - Ronilan 2 blossom sprays, 1 preharvest spray.

PREPLANT SOIL FUMIGATION

1) If you suspect root knot nematode, lesion nematode, or oak root fungus (Armillariella Mellea) you may want to fumigate with Telone or Methyl Bromide. Consult your local chemical advisor for rates and methods of application.

FROST PROTECTION

Minimum Tolerable Frost

- In November
  - with leaves males 26° F
  - without leaves males 10 - 15 F
  - (females are more tolerant)

- Spring Frost
  - frost protect after buds appear at 32° F

FROST PROTECTION METHODS

1) Orchard heaters using heating oil or propane or natural gas.

2) Wind machines (limited value)

3) Water
   - over canopy using sprinklers (8 F protection)
   - under canopy using sprinklers (4 F protection)

In California, temperatures rarely drop below 20 F, most vineyards use over canopy sprinkler frost protection.

- we use, Rainbird 14V sprinklers with 5/64" orifices
- 30' X 40' spacing
- about 50 lbs/in pressure
- this supplies about 50 gallons/Acre/minute or 0.1 inch precipitation/hour.

This gives about 6 to 8 degrees of protection.

As you know, the more water, the more protection.

As a rule, if you select a site for your vineyard - select a site that does not need protection - chances are good, that if you need more water than my example - kiwi vines may not be the right crop for that location.

RECOMMENDATIONS

1) Frost protect in the fall
   - 32 F before harvest
   - 27 F before leaf fall
   Depending on when frosts occur, you may frost protect for 1 week to 10 days, before I would stop frost protection - this allows plants to "harden"

2) Do not fertilize plants late in the summer with nitrogen. Your fertilizer program should stop application of nitrogen by the 1st of August.

3) Spring frost protection after bud-break at 32 F.

SUMMER PRUNING

1) On 4 year old vines or older - (this is different than training younger vines)
   A) Shapes plant (little benefit)
   B) Opens the canopy for good sunlight and air penetration which helps maximize photosynthate distribution
   C) Lessens botrytis problem with better air movement
   D) Deep shade fruit is often inferior in cold store life
   E) Shaded canes do not have as much fruiting potential

HARVEST

1) Monitor flesh pressures and soluble solid content of the fruit (weekly). Fruit at picking should be 6.5% soluble solid and greater than 16 lbs/in in flesh pressure. (Pressure is determined by penetrometer 8 mm tip).

2) Picking into lug boxes or shallow field bins 4' X 4' and 16" to 24" tall.

3) Avoid bruising fruit - all pickers should wear gloves.

PACKING

Many styles

1) Hand pack from tables.

2) Return conveyor belt and hand pack.

3) Weight-sizes (electronic or conventional) hand pack or tray-fill.

4) Optical or physical dimensional sizers

#1 and #2 have higher labor cost - less machine cost
#3 and #4 have higher machine cost - less lower permanent labor cost.

TYPES OF PACKAGES

1) Tray-pack
   - single layer 7 lb tray - 9 sizes - 25, 28, 30, 33, 36, 39, 42, 46, 49.

2) Volume fill
   - 1 lb bags - 20 bags per master
   - 10 to 20 lb place pack

Tray dimension 14" X 17½" X 2¼"H
Pallet 35" X 42"
Number or trays per pallet 168 or 174

Cold storage facilities should be near your packing operation.

If you want to pick - pack them in cold storage. You may want enough capacity of your packing operation to pack within 3 weeks.

Most commercial packers cold store fruit prior to packing - this is acceptable but, the fruit must be handled quickly and returned to cold storage promptly.

Depending on fruit quality - fruit can be held in bins for 6 weeks in cold storage before packing.

ACCESSORY EQUIPMENT

1) Electric fork lifts (in shed) avoid internal combusion equipment in the shed.

2) Box makers manufactured in New Zealand (makes wooden trays).

3) Bagging machines - very expensive and are not normally used unless by very large packers

FRUIT CHANGES IN COLD STORAGE

Even in the best of cold storages, problems and changes occur.

Major Problems

1) Shrivel and shrinkage

2) Mold and rot

3) Softening

4) Internal breakdown

FRUIT SHRINKAGE

1) From sunburnt fruit

2) Or from dehydration in cold storage due to improper packaging, or low relative humidity in cold storage.

MOLD AND ROT

1) From injury even if not visible at packing (botrytis)

2) Alternaria mold on external floral parts. Usually not a problem

SOFTENING

1) Premature softening occurs from dehydration or exposure to ethylene gas.

Normally, fruit softens from 20 lbs/in$^2$ to 6 lbs/in$^2$ within 8 to 12 weeks

Excessive softening prior to this occurs if ethylene concentrations are above 20 ppb in the cold storage.

COLD STORAGE RECOMMENDATION

- Ethylene concentrations in storage below 20 ppb
- 95% relative humidity
- 32 to 33 F temp.
- Air movement should be minimal

POST HARVEST COSTS

| | | #7 tray | # 1 bag |
|---|---|---|---|
| Packing | U.S. | $2.25 | 0.25 |
| cold store (2 months) | | .36 | .05 |
| sales commission | | .45 | .04 |
| advertising | | .23 | .03 |
| inspection fee | | .06 | .01 |
| | | $3.34/tray | |
| | | $0.48 lb | $0.38 lb |

PRE HARVEST COSTS

| | |
|---|---|
| Picking | $0.02/1b. |
| Pruning | .04 |
| Fertilizer | .01 |
| Equipment | .04 |
| Capital Expenses | .07 |
| Labour | .03 |
| | $0.21/1b |
| | $1.47/tray |
| Grower's break even cost | $4.81/tray $0.59/1 1b bag |

Table 1 WORLD PRODUCTION

| | 1984 | 1990 |
|---|---|---|
| France | 2,200 hectares<br>2.5 million trays | 6,500 hectares<br>10.0 million trays |
| Italy | 5,000 hectares<br>5.0 million trays | 9,000 hectares<br>21.0 million trays |
| Japan | 2,269 hectares<br>3.2 million trays | 3,173 hectares<br>16.4 million trays |
| U.S.A. | 2,943 hectares<br>4.0 million trays | 3,263 hectares<br>11.9 million trays |
| New Zealand | 15,480 hectares<br>23.5 million trays | approx same<br>63.6 million trays |
| Australia | 1,012 hectares<br>0.6 million trays | 2,000 hectares<br>6.8 million trays |
| Chile | 470 hectares<br>0.06 million trays | 3,000 hectares<br>2.0 million trays |
| | 29,374 hectares<br>39.3 million trays | 42,816 hectares<br>132.6 million trays |

Source 1985 International Kiwifruit Organization meeting, California Kiwifruit Commission

These figures may be slightly inflated. It is my belief that U.S.A. will be hard pressed to get 10.0 million trays -

Italy's figures may be inflated

Chile may be the sleeper - from early reports they are currently putting extensive areas into kiwi production.

Regardless of tonnage, even 130 million trays are not an unmarketable figure. Relative to oranges and bananas this is a drop in the bucket. Still it will take a great amount of money in advertising to sell our product. No one will venture a guess at the market saturation point for kiwifruit.

Dr. Jim Beutel - Kiwifruit Training

Training kiwifruit plants on T-bar or Pergola support systems is essentially the same during the first three or four years.

During the first season of growth the object is to train the plant up the training stake to the point where it touches the center wire. After growth begins in the spring, select a robust shoot to be trained upward. The plant's vigor should be concentrated into one shoot to encourage maximum growth and a straight, strong trunk. Eliminate or pinch back all cane growth on the trunk at this time. To develop leaves to provide for carbohydrate manufacture and to shade the trunk, some growers leave shoots on trunks for 1 to 2 years and keep them cut back to a lenght of 6 to 10 inches. Other growers eliminate most growth from the trunk forcing maximum upward growth of the main shoot. Once the selected shoot has developed some rigidity, tie it to the training stake. If growth decreases in size or vigor, head back the terminal growth. Continue this process of heading back and tying as needed until the vine reaches the top wire (figure A). If this is achieved before the end of the first growing season, head the vine back 2 to 3 inches below the wire and train the new growth in opposite directions down the center wire to form the two main arms called cordons (figure B). During dormancy of the first year prune the cordons back to pencil-sized or larger wood (figure C). Do not allow the vine to twist or wind around the training stake or center wire. Make sure the cordons are hung over the center wire and are properly tied to it.

In the second season of growth train a vigorous shoot in either direction from the trunk along the center wire to form the two permanent cordons of the vine. As lateral growth develops, train these shoots approximately perpendicular to the main cordon at 6 to 12 inch intervals. Head back all growth that becomes spindly before tangling and twisting occurs around the desirable cane growth. Also, remove any trunk suckers. During dormancy of the second season, again eliminate any new growth on the trunk. Prune both the main cordons and the lateral canes back to pencil-sized or larger wood (figure D).

In the third and fourth growing seasons, continue to encourage the strongest shoots down the center wire until they come into proximity of adjacent plants. Continue to train lateral canes perpendicular to the main vine, and eliminate suckers or side growth from the trunk (figures E and F). In dormancy cut back the canes and cordon to pencil-sized wood. Over-fruiting at this point (third year) will inhibit fourth-year growth, a paramount year in kiwifruit vineyard development for future years of commercial growth and production (figure G).

By the fourth year the permanent vine structure has been established. Henceforth, all pruning is done with an eye toward replacing strong fruiting canes for the new crop (figures H and I). For more detailed directions on pruning bearing kiwifruit vines see the section on pruning.

## PRUNING KIWIFRUIT VINES

There are probably as many different ways to prune kiwifruit vines as there are growers. Some basic techniques and principles are given to guide growers in pruning by the cane renewal system widely used in California.

Dormant pruning on older vineyards should begin as soon as most of the leaves have fallen. In the central valley of California (Kern County north through Butte County) frost occurs sometimes in December, causing leaves to fall, making pruning practical. In February canes bleed badly after pruning so this leaves only 4 to 9 weeks for pruning. Many of these days may be rainy so the grower has limited time for dormant pruning. In other areas of California the pruning season may be longer or later.

The amount of wood removed will vary with the age and vigor of the vine and will range from 20% on young vines to 70% on older vines.

Sunlight is very important to fruit-bud formation on growing canes. Where young vines are lightly foliated they may have sunburned fruit and good flower buds, but as the vines get older, the problem becomes one of excess foliage and "shading out" of lower canes. Lower shaded canes are not nearly as fruitful as top layer canes. Although summer pruning for sunlight penetration is not common in California, many growers with good, firm, storage fruit spend a great deal of time in the summer trimming and training canes for the following year's crop and to let light into vine canopy without sunburning fruit. Vines that are only lightly pruned will become increasingly unproductive in eighth and future years due to exessive shading, and soft fruit is often a problem in these vineyards.

Pruning will have a substantial effect on the size of individual kiwifruits. if canes smaller than pencil-size (¼-inch diameter) are left for fruiting, generally smaller fruit will develop from them than would from larger canes. If more fruit wood is left on the vine than it can handle, overcropping and small fruit will occur. This will also affect the following year's crop because fewer productive canes will grow due to overcropping.

Symptoms of overcropping are about the same as under-watering in the summer. Often these two problems will combine and are hard to differentiate. When very large crops of small fruit are observed, ample water has been provided and soil moisture is good all summer, the problem can often be traced to inadequate winter pruning. Conversely, overpruning may reduce the overall crop tonnage but give large sizes.

Mature vines should be prevented from intertwining with neighboring vines. A vine should be pruned to stay within the trellised area designed for it. On T-bar systems canes growing past the outer trellis wire into the row, or drooping to the ground, can prevent or hinder vineyard operations. Pergola systems should be pruned back in the dormant season sufficient to

permit good light between each row of vines at pollination time.

## PRUNING CONCEPTS AND GUIDELINES

Certain pruning principles and concepts are essential for understanding pruning of kiwifruit vines.

1) Fruit is produced on current season's wood that grows from buds developed on the previous year's canes.
2) Fruiting canes are current-season's growth which have fruits on the basal 4 to 6 buds, and all buds beyond the fruit are capable of producing shoots that will have flowers and fruit next year.
3) Growth that occurs from buds heavily shaded during the previous season will be less fruitful than from those that received ample sunlight.
4) Fruit will not develop on shoots that emerge from two-year or older wood.
5) Male plants are pruned differently than female plants.

## PRUNING FEMALE (HAYWARD) VINES

Dormant pruning of female vines begins by removing older wood that has already fruited. Usually new fruiting laterals will have developed from the base of these same older fruiting canes or from the cordons (main arms) of the plant. When necessary, second year canes can be left for fruiting when enough new growth exists (18-48 inches). Most of the older wood is removed back nearly to the main cordon, and only new fruiting laterals are left. Twisted and tangled growth, as well as canes crossing from one side of the plant to the other, are removed during dormant pruning. Canes broken by wind or mechanical damage also are removed. Any growth interfering with sprinklers, hanging to the ground, growing straight up in the air, or invading neighboring plant space should be pruned out or tied up. When excess fruiting laterals exist in one area, prune them out so that 8-12 inches separates each cane. Most kiwifruit vines in California 6 years or older can support good crops of large-sized fruit with 30 to 45 canes per plant. This is approximately one cane on each side of the cordon every foot down the center wire. If vines are only 15 feet apart in the row, 30-35 canes are good and if 18 to 20 feet apart, 36-45 canes are good. Some growers may find by experience that fewer canes per plant are better for their situations. By pruning and tying a single layer of canes during dormancy, opportunity is provided for sunlight to favor new robust growth and fruit development for the year ahead. The canes left for next year's crop are headed to force enough fruiting canes to make a good crop. Sometimes one-third of the cane length is removed at the time of heading, but amount of wood removed at this time by age of plant, trellis system and grower preference and experience varies.

## PRUNING MALE VINES

Pruning of the male vine varies from no pruning at all to cutting back 70% of the plant after bloom. There are several schools of thought and each

grower must decide what method best serves his need.

One method of pruning male vines is to head back the larger canes during summer with the remainder of pruning being done during dormancy. Another method is to cut most of the canes back to 6 to 12 inch stubs on main arms as soon as flowering is finished. New growth will grow during the summer making adequate wood for next year's bloom. It is advisable to leave some leaves for shade of the cordon to prevent sunburn in hot areas. White latex paint put on cordons provides some sunburn protection, too.

Regardless of the method employed, it is well to keep in mind that

1) The goal is to prune the male plant in such a manner that it will have blooms from the time the female plant begins blooming until the time it finishes.
2) Prune in winter and summer to control male plant growth and prevent enroachment over the female plants.

## PRUNING KIWI VINES IN SOUTHERN CALIFORNIA

In Southern California and the central coast areas, kiwi vines drop their leaves later in winter than in Northern California (Kern north to Butte County). In Southern California, vines start growing in April instead of February so pruning is later and different than in the north. Also, winters are warmer in the south and along the coast resulting in less winter chilling which causes less fruiting and branching of canes. Opinions vary of the best pruning methods and timing. A few general points will be made about kiwi pruning in Southern California. Vines must be pruned each winter cutting off most of the older fruit wood but leaving two foot or longer canes for next year's crop. This is done in February or March after the winter is nearly over. Since fewer buds grow per cane in Southern California compared to Northern California, more canes may be left and all should be cut leaving 4 to 8 buds per cane. Usually 2 to 4 buds will produce new fruiting canes for next season. If a cold winter occurs, more buds will grow. When this in known at time of pruning, longer pruned canes may be left to take advantage of the better growing and fruiting conditions that year.

## SUMMER PRUNING

Pruning kiwifruit vines in the summer varies greatly between California growers. It appears necessary to summer prune older vines to prevent excessive shading which reduces next year's crop and often causes soft fruit during the current season. All New Zealand growers summer prune heavily, especially Pergola trained vines. The most common summer pruning method in California is to cut windows in the top canopy where fruit are few in number or to cut alley ways between rows of kiwifruit vines to let sun into the pergola. Too much pruning at one time causes much sunburn of fruit and canes. Summer pruning may start in June and be repeated in August. Selective pruning of new shoots is practiced by several successful growers who produce good crops of firm, long-storing kiwifruit.

# TRAINING OF KIWI VINES
## SIDE VIEW
## PLANTED SPRING 1981

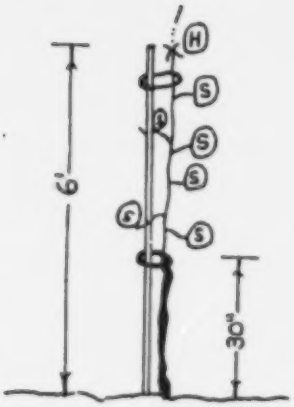


Figure A
Summer 1981 — First Leaf

(S) = Head back side shoots to force growth of top during the summer.

(H) = Heading cut made in summer or in dormant season to force future cordons (Fig. B).

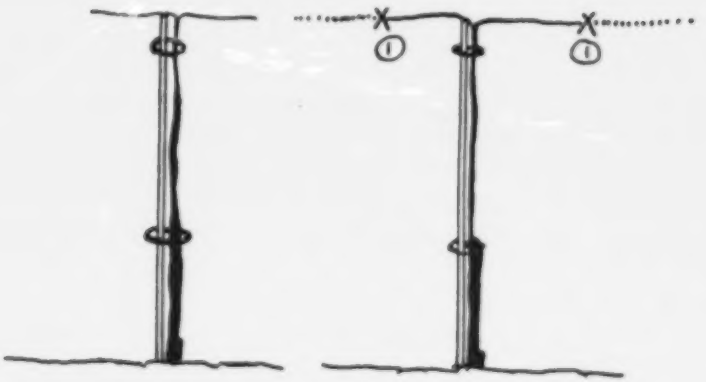


Figure B
Fall 1981 — First Leaf

○ = Trunk tied with tape to training stake.

Figure C
December 1981 — End First Leaf

(1) = Cut cordons to force future fruiting canes for future years.

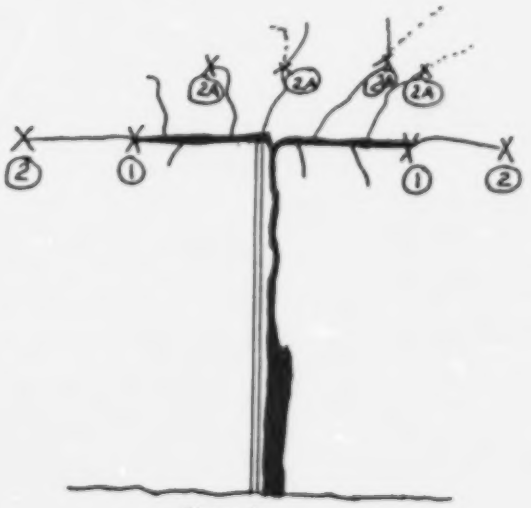


Figure D
December 1982

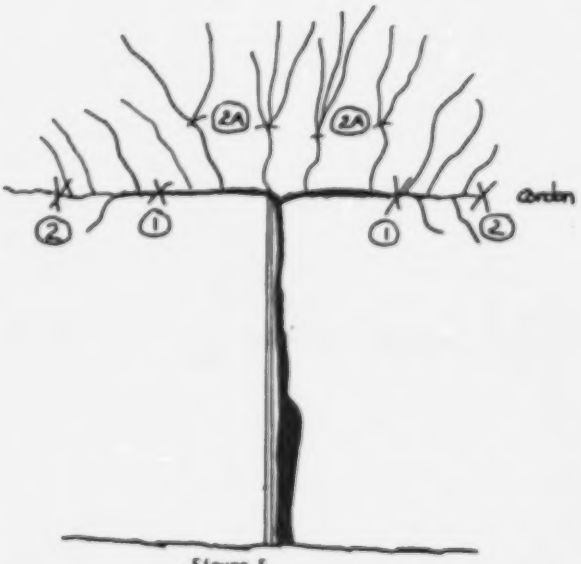


Figure E
Spring 1983

Figure D
December 1982 — End of Second Leaf

(2) = Head cordon in dormant season to force more fruiting canes next year.

(2A) = Cut back canes to force buds to produce fruiting canes next year.

Figure E
Spring 1983 — Third Leaf

Cane growth in spring following dormant pruning.

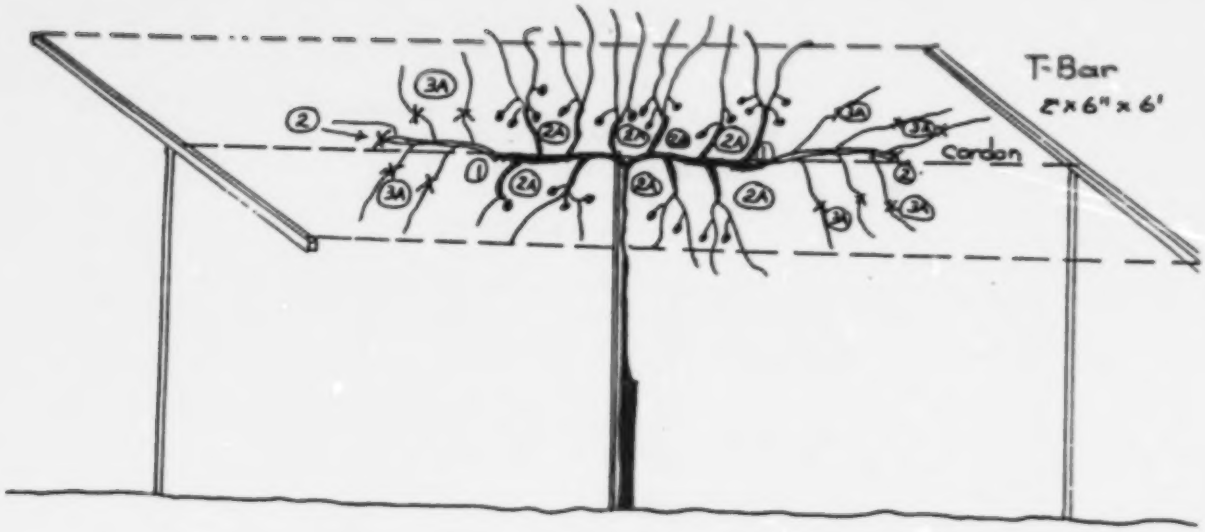


Figure F
Fall 1983 Before Harvest — Third Leaf

= Fruit to be harvested in Fall 1983.

(1) = Point where cordon was headed in December 1981.

(2) = Cordon headed back in Fall 1982 which forced cane growth shown between cuts 1 and 2.

(2A) = Canes headed back dormant 1982 that forced cane growth and fruit shown.

(3A) = 1983 canes will be headed December 1983.

**PRUNED KIWI VINES – TOP VIEW**

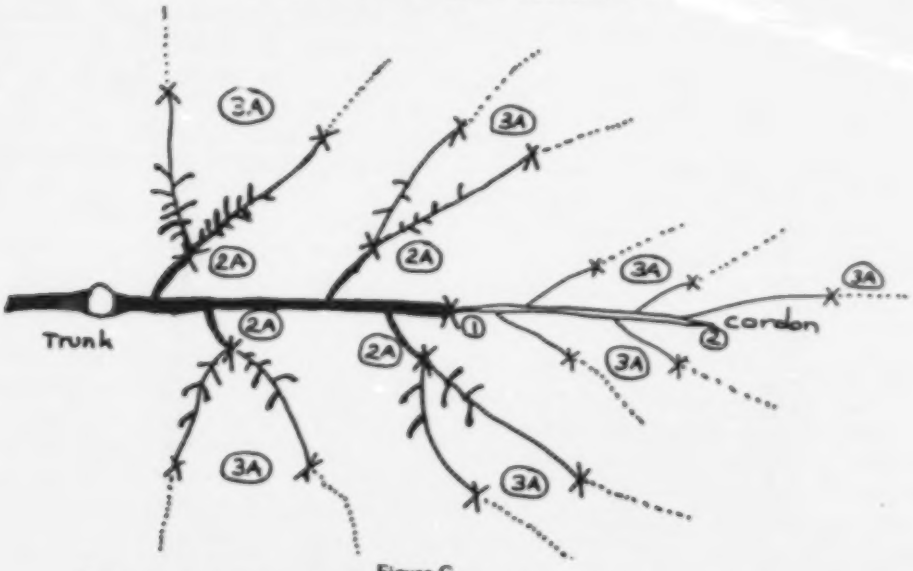


Figure G.
Close-up view of pruning done December 1983 — End of Third or Fourth Leaf

= Stems remaining after harvest 1983.

(2) = Fall 1982 cordon cut.

(2A) = Canes cut Fall 1982 (see previous figures)

(3A) = Pruning after first crop. Headed fruiting canes and new canes that grew from cordon.

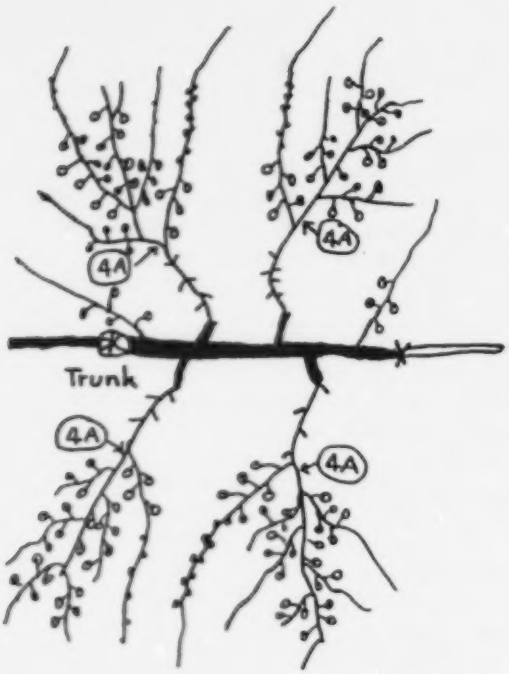


Figure H
Fall 1984 at harvest time (before pruning)

(4A) = Shows where dormant pruning cuts will be made in December 1984 to remove canes that produced last season's (1984) crop.

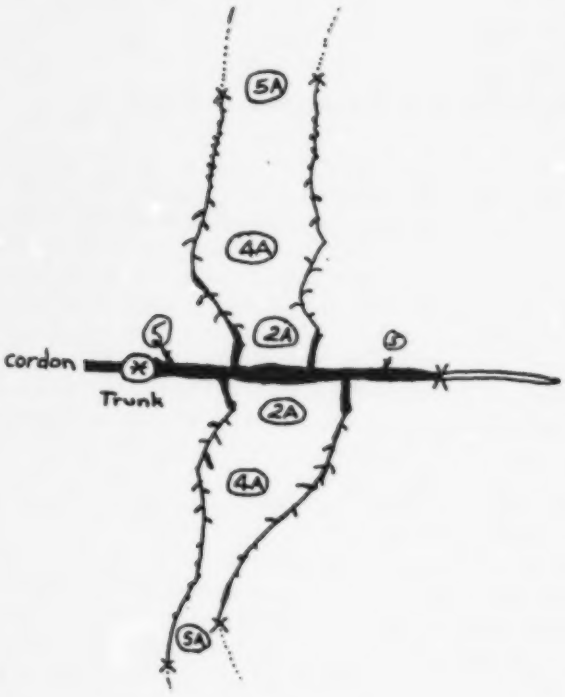


Figure I
January 1985 (after winter pruning, December 1984)

(4A) = Point where last year's fruiting wood was cut.

(5) = Stubs left after pruning out old fruiting canes December 1984.

(5A) = Fruiting canes cut to force dormant buds to produce fruiting canes for 1985 season.

= Stems of fruit harvested last 2 years.

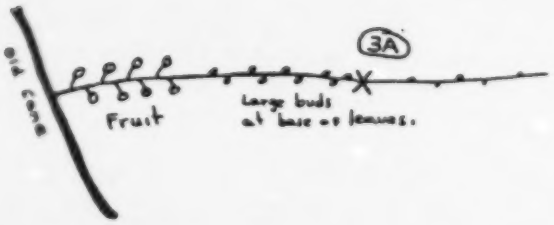


Figure J
Diagram of kiwifruit canes showing location of fruiting buds and future fruiting canes.

= The large buds at the base of the leaves will produce next year's fruiting canes.

(3A) = Head this cane removing ⅓ of its total length.

Nick Pyke - D.S.I.R. New Zealand

Kiwifruit (Actinidia deliciosa) has been developed from a fruit crop which grew only in the wild in China or as small backyard plantings elsewhere in the world to a major fruit crop in the last 30 years. The developments in such a rapidly growing fruit industry are considerable and have occured in all parts of the industry: plant breeding, plant production, crop quality, packaging, fruit storage and transportation, marketing and processing in many countries of the world. In this paper it is possible to consider only a few of the developments which have occured and the developments discussed are those which could have major influences on or are applicable to the stage of development of the kiwifruit industry in British Columbia.

The "historical developments" which have allowed the industry to develop are probably an important background for any kiwifruit industry. New Zealand is not in fact the home of kiwifruit. One of the major developments was the introduction of seed of the Chinese Gooseberry or Yang Tao to New Zealand from China by a nurseryman near the turn of the century. The worldwide kiwifruit production is reliant on varieties which all have their origins with this seed importation. The plants grew as Chinese Gooseberries in small commercial plantings in New Zealand until the 1960's and 1970's when the export of fruit increased, "Hayward" emerged as a preferred commercial cultivar and an enterprising export company invented "kiwifruit".

In New Zealand kiwifruit production has and will continue to increase rapidly for a number of years (Table 1) and it is estimated that in 1990 New Zealand will have approximately 53% of the world production. Kiwifruit are now grown throughout the North Island of New Zealand and also in the north of the South Island. All growing areas are producing kiwifruit which are picked, packed and exported to the world. The major consumers of kiwifruit are Japan and Europe with only 16% of NZ production coming to North America. With the increased volumes of fruit (also the fluctuating New Zealand dollar) prices have dropped and the huge returns to kiwifruit growers are probably a thing of the past.

## FROST DAMAGE

One of the major problems influencing kiwifruit production throught out the world is the climate. Production in B.C. will depend on the ability of researchers and growers to develop systems which allow culture in this climate.

Kiwifruit are susceptible to cold damage at any stage of the growing season the tolerance obviously varys with the stage of plant development, the age of the plants and the methods of orchard management.

## TRUNK DAMAGE

Trunk damage as a result of frosts has occured in New Zealand, France, U.S.A. and Canada. This winter in B.C. a number of plants have been lost both at Langley and on Vancouver Island. Frost damage may appear as minor splits on the plant trunks up to about 2' above the ground. These may heal in the following summer. However if the damage is more severe then the bark becomes detached from the xylem and the plant is ringbarked and killed to ground level. Plants killed to ground level will usually produce new shoots from below the damage zone which can be used to rapidly produce new plants. On some plants no damage is apparent as splitting but cutting into the bark and vascular tissues can show some browning and discolouration. The damage often appears first on the south-east or south-side of the plant. It may appear almost immediately after the frost or plants may not show any damage until in the spring-summer following the frost.

## WHEN DOES PLANT DAMAGE OCCUR?

The plant is susceptible to trunk frost damage throughout the whole year but it is most likely to be damaged by early autumn frosts, i.e. October, November before the plant has become dormant or by spring frosts when the plant has reentered active growth.

Often it is the first severe frost in the autumn which causes the damage.

## WHAT TEMPERATURES CAUSE DAMAGE?

Kiwifruit plants were exposed to controlled environment frosts in a research trial. From these experiments it is not possible to determine how much damage would occur if the "Hayward" plant was exposed to the cold temperature for either shorter or longer periods of time. The plant tolerance increases from November to December and decreased again through to March. Visible damage and plant death occured after -7 C. Some plants survived December frost of -13 C but all plants were damaged and bud development was greatly reduced.

In the field temperatures of -6 C in the autumn have been reported to cause plant losses in France and New Zealand and some damage has been reported after frosts of -3 C.

## VARIETAL AND SPECIES SUSCEPTIBILITY

The susceptibility of a clone of "Hayward" and a clone of "Bruno" have also been tested in controlled environment conditions in both November and December. In November "Bruno" plants were damaged at warmer temperatures although death occured at warmer temperatures in "Hayward". In December a similar trend was evident. The susceptibility of "Hayward" and a seedling rootstock to frost damage in the field also differed.

There was more frost damage and death of above ground plant parts in "Hayward" than in the seedling rootstock. However the damage in some seedlings and the fact that some of the scions on the seedling rootstocks were damaged down to the graft suggests that there is alot of variability in the frost tolerance of Actinidia deliciosa. Frost damage often appears in the male plants because they usually become dormant later in the autumn and are more susceptible to early autumn frosts.

## TRUNK PROTECTION

Trunk damage usually occurs as a result of the early frosts in the autumn before the plants are fully dormant. Therefore any practice which increases plant hardiness in the early autumn should reduce plant damage. Some practices like reducing fertilizer applications to reduce plant growth, minimizing irrigation in the autumn and leaf defoliation are currently being trialled. As the plants get older the trunk and the bark on the trunk thicken and the plant becomes more tolerant to frost. If good plants are used at planting the number of years when they are susceptible to frost will be reduced.

Insulation materials as trunk wraps have been used to protect a number of crops throughout the world. A number of materials were tested for their insulation properties and six are now being tested in field trials. Some of the materials which have been tested are hay wrapped in black polyethylene, silver backed insulation foil, sawdust mounds and a close cell polyurethane foam. A material which maintains the nighttime minimum higher and the daytime maximum lower than ambient temperature is most preferred. These insulation materials may be effective when overnight frosts occur and daytime temperatures come above freezing but probably provide only limited protection during prolonged freezes.

Because of the differences in frost tolerance of kiwifruit seedlings it should be possible to select more hardy rootstocks from the breeding programs which have been initiated throughout the world.

If a plant shows splitting symptoms but is not killed it is beneficial to paint the damaged zone with a pruning paste which dries, seals and protects the trunks.

## DAMAGE TO OTHER PLANT PARTS

### VEGETATIVE SHOOTS

Vegetative plant parts, new shoots and leaves, can be damaged by exposure to -0.5 C for 6 hours in the controlled environment and have been damaged in the field when temperatures were below freezing for 2½ hours with minimum temperatures of -1 C. Temperatures warmer than -0.5 C may cause chilling damage to new leaves.

## FLOWERS

The flowers, which open in late spring, can be damaged when the temperature drops below -0.5 or -1.0 C. Severe damage to flowers will prevent further flower and fruit development however the fruit which develop from flowers with minor damage are often misshapen and unsuitable for sale.

## FRUIT

The fruit are harvested in late October - November. Close to harvest the fruit are susceptible to frost damage. Temperatures of -1 to -1.5 C for nine hours caused damage to exposed fruit although the fruit under the plant canopy were approximately 1 C warmer and showed no damage. The extent of the damage in the fruit is dependant on the severity and duration of the frost. Minor frost damage appears as slight watersoaking in the fruit core and some damage to the fruit shoulders.

Severe damage appears as widespread watersoaking in the core and on the fruit shoulders and in some cases the fruit became discoloured and dehydrated.

Frost damaged fruit will not store as well as undamaged fruit and has poor flavour.

## BUDS

Autumn and winter frosts can damage buds on the reproductive plant framework. The bud burst can be reduced in a similar way to that which occured on trunks exposed to cold temperatures. Replacement canes and the permanent plant framework may also be damaged. The damage appears as brown cambium cells under the plant bark and darkened xylem tissues.

## FROST PROTECTION

There are a number of practices which can be used to protect orchards from frost and developments have occured with regard to both passive and active frost protection in recent years.

Passive protection methods aim to maintain warm surface temperatures. The factors that can be manipulated to increase the air temperature are;

1) Careful block section: In marginal areas sites which are naturally warmer with good air drainage should be selected. Thermometers should be installed and monitored for one year prior to planting to identify warm and cold areas in the site.
2) Good air drainage: While shelter is essential for kiwifruit production in most parts of the world, the design of shelter to promote air drainage and minimize cold air ponding is important. Strategically located gaps should be incorporated into the shelter system at low lying corners of

the orchard. Streamers should be installed and monitored for one year prior to planting to help determine shelter needs.

3) The temperature above a bare, moist, firmly compacted soil or above a short grass sward is warmer than above loose, dry weedy soils.

## ACTIVE FROST PROTECTION

### WATER

This is the major active frost protection system used in orchards and overhead irrigation systems applying 3.0 mm/hr have been shown to be effective to -6 C provided the system is started before temperatures drop to 0 C and run until they come above 0 C. These systems have a number of disadvantages. They require large volumes of water which can cause waterstaining to fruit and, on poor draining soils, could cause plant losses due to waterlogging.

In the past 2 years considerable research has been done on the use of targeted frost protection. These systems use overhead minisprinklers which are only wetting the crop row and thus minimize the water usage and avoid soil waterlogging problems. Researchers in Florida have investigated the use of minisprinklers and other undervine sprinklers for frost protection. All of these systems provide some protection but targeted frost protection may be almost as effective as total overhead high volume frost protection systems.

### AIR MOVEMENT

Air movement methods, using either wind machines or helicopters, have been successfully used in kiwifruit frost protection. Air movement methods are dependant on the presence of an inversion layer and movement of the warm air down into the orchard environment. Both wind machines and helicopters can increase air temperatures by 1 - 2 C but because of the sheltered orchard environment there use is limited to single shelter blocks.

In the climate of B.C. frost management will be critical for kiwifruit production and the integration of a number of systems may be required to minimize frost damage in kiwifruit.

Table I

KIWIFRUIT PRODUCTION IN NEW ZEALAND

| YEAR | AREA PLANTED Hectares | PRODUCTION Trays (millions) | PRODUCTION Tonnes |
|---|---|---|---|
| 1980 | 7,000 | 5.3 | 18,500 |
| 1985 | 14,000 | 23.7 | 83,000 |
| 1986 (expected) | 17,000 | 30.0 | 105,000 |
| 1990 | 17,000 + | 63.6 | 222,000 |

OF THIS PRODUCTION, ONLY 14% IS EXPORTED TO USA.

Table II

SUSCEPTIBILITY OF 'HAYWARD' AND 'BRUNO' TRUNKS TO FREEZE DAMAGE

| MONTH | VARIETY | TEMPERATURE C TREATMENT | DEAD PLANTS % | DAMAGED PLANTS % |
|---|---|---|---|---|
| November | Hayward | - 5 | 0 | 0 |
| | | - 7 | 17 | 50 |
| | | - 9 | 100 | 100 |
| | Bruno | - 3 | 0 | 0 |
| | | - 5 | 0 | 33 |
| | | - 7 | 0 | 100 |
| | | - 9 | 100 | 100 |
| December | Hayward | - 5 | 0 | 0 |
| | | - 7 | 0 | 0 |
| | | - 9 | 17 | 33 |
| | | -11 | 33 | 67 |
| | | -13 | 67 | 100 |
| | Bruno | - 5 | 0 | 0 |
| | | - 7 | 0 | 33 |
| | | - 9 | 0 | 50 |
| | | -11 | 17 | 67 |
| | | -13 | 33 | 100 |

## ESTIMATED WORLD PLANTING AND PRODUCTION OF KIWIFRUIT

| By Countries: | Plantings (ha) | | Production (tonnes) | | Export (tonnes) | |
|---|---|---|---|---|---|---|
| **NORTHERN HEMISPHERE** | 1984 | 1990 | 1984 | 1990 | 1984 | 1990 |
| FRANCE: | 2,600 | 6,500 | 11,100 | 37,000 | | |
| GREECE: | 550 | ? | 1,150 | 8,000 | | |
| ITALY: | 5,000 | 9,000 | 10,000 | 70,000 | | |
| ISRAEL: | 40 | ? | 40 | 800 | | |
| JAPAN: | 2,269 | 3,173 | 10,764 | 54,740 | | |
| SOUTH KOREA: | 183 | ? | 430 | 2,745 | | |
| SPAIN: | 100 | ? | ? | 2,000 | | |
| OTHERS (UK, Taiwan): | 100 | 300 | ? | 2,000 | | |
| PORTUGAL: | 50 | ? | ? | 1,000 | | |
| USA: (California): | 3,100 | 3,303 | 19,400 | 44,200 | | |
| (other States): | 50 | 160 | ? | 1,000 | | |
| CANADA: | ? | 600 | ? | 3,000 | | |
| TOTAL Northern Hemisphere | 14,042 | 23,036 | 52,884 | 226,485 | | |
| **SOUTHERN HEMISPHERE** | | | | | | |
| AUSTRALIA: | 1,012 | 2,000 | 2,222 | 25,185 | | |
| CHILE: | 470 | 3,000 | 200 | 9,400 | | |
| NEW ZEALAND: | 15,480 | 22,000 | 108,800 | 294,600 | 87,000 | 235,000 |
| SOUTH AFRICA: | 246 | 600 | 20 | 5,000 | | |
| ZIMBABWE: | 30 | ? | 30 | 600 | | |
| OTHERS (eg Argentian etc) | ? | 500 | ? | ? | | |
| TOTAL Southern Hemisphere | 17,238 | 28,100 | 111,272 | 334,785 | | |
| TOTAL WORLD | 31,280 | 51,136 | 164,156 | 561,270 | | |